Analyzing Alternative Fuel Combustion

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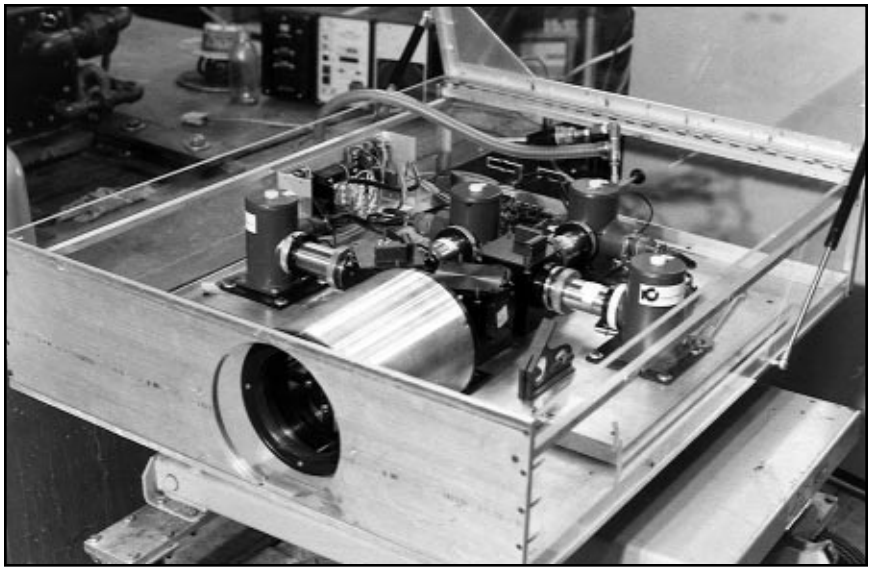
Objectives

- To extensively investigate details of cylinder processes of alternative fuel-operated internal combustion (IC) engines by using the new Super Imaging System (SIS) developed at Rutgers
- To further improve SIS for performing a wide range of combustion processes for many engine-fuel variables.



Assembly of four-color, high-speed spectral infrared imaging system for analyzing in-cylinder combustion

Approach

The system performance of the SIS (which is now being further improved) enables four geometrically identical infrared (IR) images in respective bands to be obtained simultaneously at very high rates from IC engines that have optical access.

Digital data obtained from corresponding pixels over the spectral images are processed using new spectrometric analysis methods to explain many unknown variables associated with alternative fuel combustion in IC engines.

The study is performed in spark ignition (SI) and compression ignition (CI) engines that have either an IR or a visible-ray window.

In two SI engines, both the conventional port-injection type fuel injector unit and the air-assisted (Ford Motor) injection system are used. Similarly, either a mechanical PT (Cummins Engine) injector or an electronically controlled Servojet (BKM) system is mated in the CI engine.

Accomplishments

The engines and SIS system are being improved to enhance the consistency and quality of the results.

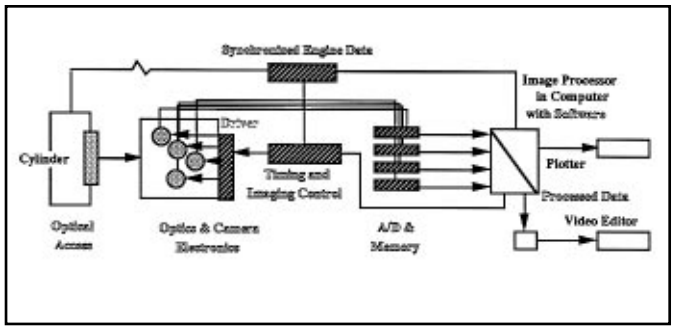
The optical access in the existing SI engine was modified to maximize radiation energy for imaging. The second single-cylinder SI engine apparatus is newly constructed using Ford 4.6 modular engines, which can be mated with either a two-valve or a four-valve head. (One feature of this engine is that it operates at high speeds.)

A new electronically controlled fuel injector for the existing CI engine is being designed specifically to perform alternative fuels combustion study. This new injector will facilitate in-cylinder investigation of CI combustion with tailored fuel injection, which includes multiple and pilot injection for gaseous fuel fumigation.

The electronic and optical components of the SIS, which became operational in early 1994, are being modified to minimize the noise:signal ratio and maximize the radiative energy to be captured by the SIS.

Future Direction

As soon as the system units are satisfactorily improved and constructed, the in-cylinder processes will be investigated for several alternative fuels, including natural gas, hydrogen, hythane, propane, gasoline (as a base fuel), alcohols, and others, as chosen in close consultation with DOE and NREL scientists.



Publications

Jeong, Y.I., Y. Quian, S. Campbell, and K.T. Rhee. 1994. "Investigation of a Direct Injection Diesel Engine by High-Speed Spectral IR Imaging and KIVA-II," SAE paper 941688.

Kajitani, S., H. Usisaki, E. Clasen, S. Campbell, and K.T. Rhee. 1994. "MTBE for Improved Diesel Combustion and Emissions?" SAE paper 941688.

Clasen, E., S. Campbell, and K.T. Rhee. 1995. "Spectral IR Images of Direct-Injection Diesel Combustion by High-Pressure Fuel Injection," SAE paper 950605.